Echo Lake Water Quality

A Report on Water Quality Monitoring Results
for Water Year 2010 at Echo Lake

King County Lake Stewardship Program

Prepared for the City of Shoreline
by the King County Lake Stewardship Program

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King County

Overview

The King County Lake Stewardship Program (KCLSP) began working with volunteer monitors to monitor Echo Lake in 2001. The lake was not monitored in 2002, but work resumed in 2003 and has continued to the present. In 2005, City of Shoreline staff members began monitoring the lake according to the protocols and schedule of the volunteer monitoring program run through the KCLSP. The water quality data indicate that currently the lake is moderately high in primary productivity with fair water quality.

This report refers to two common measures used to predict water quality in lakes. The Trophic State Index or TSI (Carlson 1977) is a method of calculating indicators from collected data that allows comparison between different parameters and predicts the volume of algae that could be produced in the lake. A second measure is the nitrogen to phosphorus ratio (N:P), which is used to predict what groups of algae may become dominant in the lake during certain periods. Both the TSI and N:P ratios have been calculated using the available data collected through the volunteer monitoring program.

The discussion in this report focuses on the 2010 water year. Specific data used to generate the charts in this report can be downloaded from the King County Lake Stewardship data website at:

http://www.metrokc.gov/dnrp/wlr/water-resources/small-lakes/data/default.aspx.

Or can be provided in the form of excel files upon request.

Physical Parameters

Water temperatures during the May-October sampling period generally followed a pattern similar to other lakes in the region, with cool temperatures in the spring, followed by summer maximum temperatures occurring between mid-July and mid-August, and temperatures cooling slowly in the fall (Figure 1). Excellent temperature records were kept by City of Shoreline staff performing the monitoring in 2010. Echo Lake water temperature ranged from 13.2 degrees Celsius to 22.8 degrees Celsius with an average of 17.9. Compared to other lakes monitored through the KCLSP in 2010, Echo Lake is in the lower third in terms of summer temperature maxima. The peak temperature was in late July - early August.

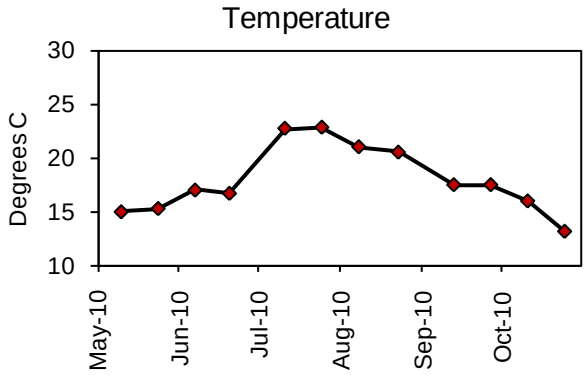

Figure 1. Echo Lake Water Temperatures

Secchi transparency is a common method used to assess and compare water clarity. It is a measure of the water depth at which a black and white disk disappears from view when lowered from the water surface.

For Echo Lake, Secchi transparency values from May through October ranged from 0.9 m to 2.9 m, averaging 2.0 m (Figure 2). Compared to data collected in previous years, the Secchi transparency values exhibited similar variability through the season. The low values in mid-June coincided with high chlorophyll values (see later in this report), indicating that decreased transparency was due to an algae bloom. This may also be true of the August values, although the chlorophyll values were lower at that time than in mid-June.

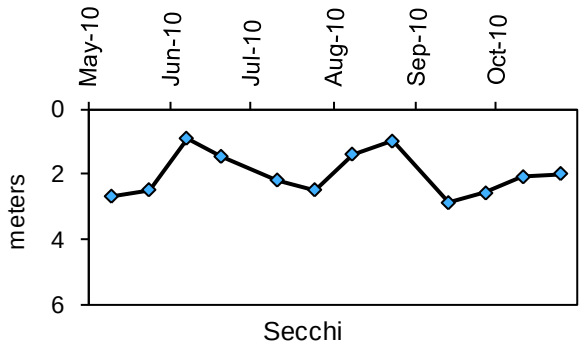

Figure 2. Echo Lake Secchi Transparency

Nutrient and Chlorophyll Analysis

Phosphorus and nitrogen are naturally occurring elements necessary in small amounts for both plants and animals. However, many actions associated with residential development can increase concentrations of these nutrients beyond natural levels. In lakes of the Puget Sound lowlands, phosphorus is often the nutrient in least supply, meaning that biological productivity is often limited by the amount of available phosphorus. Increases in

phosphorus concentrations can lead to more frequent and dense algae blooms, making a nuisance to residents and lake users and a potential safety threat if blooms become dominated by species that can produce toxins. Samples collected by volunteers are analyzed for total phosphorus (TP) and total nitrogen (TN) concentrations at one meter depth.

Total phosphorus (TP) and total nitrogen (TN) increased from May to a peak in June, followed by a decrease in July and a smaller peak in nitrogen only in August, then both nutrients rose again on the last date of sampling (Figure 3). The large increase for both TN and TP in June can be attributed to algae blooms being present, while the August peak is less clear.

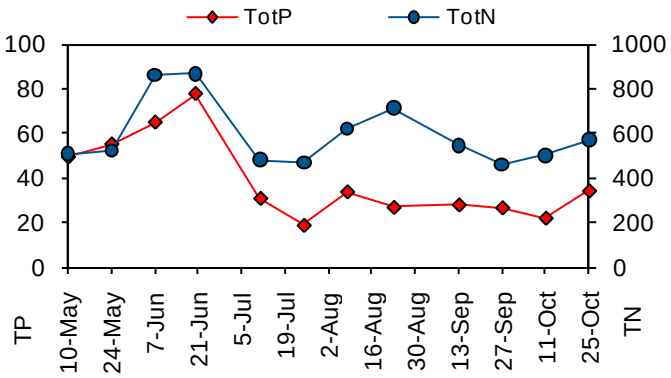

Figure 3. Echo Lake Nutrients

The ratio of nitrogen (N) to phosphorus (P) can be used to determine if conditions are favorable for the growth of cyanobacteria (bluegreen algae) that can impact beneficial uses of the lake. When N:P ratios are below 20, cyanobacteria often dominate the algal community due to their ability to take nitrogen from the air. In 2010, the N:P ratio at Echo Lake ranged from 9.2 to 26.5 with an average of 17.1, which indicated that the conditions in the lake were favorable for bluegreen algae blooms for much of the sample period. This is consistent with the abundant bluegreen algae found in the lake at times throughout the season.

Chlorophyll *a* values in 2010 made a large peak in June, coincident with the nutrient peaks, with a minor peak in early August and a slight increase through October (Figure 4). Large-sized bluegreen colonies dominated the lake through the season, trading off over summer between *Aphanizomenon flos-aquae* and *Anabaena* species. These can became patchy in distribution around the lake as a result of wind pushing the buoyant algae against the shorelines. Thus accumulations along the shoreline may not relate to how much algae is present mid-lake at the designated station and vice versa.

Pheophytin, a decomposition produce of chlorophyll, remained at low levels most of the season except for an increase during the blooms and at the end of the sampling season.

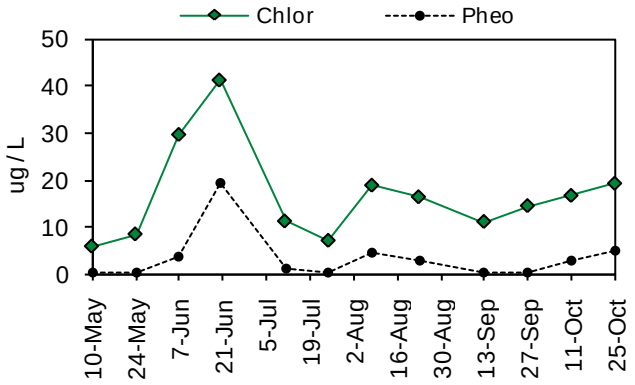

Figure 4. Echo Lake Chlorophyll *a* and Pheophytin Concentrations

Profile data indicate that thermal stratification was present early in the season and persisted through the summer (Table 1). For the events sampled in both May and August, the deep (7 m) meter samples had elevated concentrations of phosphorus and orthophosphate. Ammonia concentrations were also high, suggesting that anoxic conditions contributed to the elevated nutrient levels in the deep water via sediment release.

Chlorophyll data suggest that in the middle of the lake, algae are distributed fairly evenly through the water column. The high pheophytin value for the deep sample in August suggests that the sample was taken fairly near the bottom and may have had a little sediment mixed in. This would also explain the very high total phosphorus value as well.

Table 1: Echo Lake Profile Sample Analysis Results

Lake name	Date	Secchi	Depth	DegC	Chlor-a	Pheo	Total N	NH3	Total P	OPO4	UV254	Total Alk
Echo-Shore	5/24/10	2.5	1	15.3	8.4	<MDL	0.523	0.008	0.0551	0.0075	0.076	16.7
			3	15.3	10.0	<MDL	0.255		0.0270			
			7	9.7	6.5	<MDL	0.784	0.323	0.1030	0.0746		
Echo-Shore	8/23/10	1.0	1	20.5	16.4	2.9	0.712	<MDL	0.0269	0.0022	0.101	19.5
			3	20.5	18.7	5.5	0.815		0.0475			
			7	10.0	19.3	29.8	1.260	0.867	0.4310	0.1100		

NOTE: In Table 1, <MDL stands for "below minimum detection level" of the analytical method.

The relatively low values for UV254 indicate that the water of the lake is clear, with little coloration from organic substances, while the total alkalinity values show that the water in the lake is soft and only lightly buffered from pH change.

TSI Ratings

A common method of tracking water quality trends in lakes is by calculating values for the "trophic state index" (TSI), developed by Robert Carlson in 1977. TSI indicators predict the biological productivity of a lake based on water clarity (Secchi transparency), as well as concentrations of total phosphorus and chlorophyll *a*.

For Echo Lake, the annual average of the 3 indicators from 2001 through 2010 does not show a solid trend towards change over time. However, both 2009 and 2010 showed increases from 2008 and the average value for 2010 was the highest since monitoring began (Figure 5). The Secchi measurement generally predicted lower algal biovolumes than the other two parameters, which may be due to the clumping or particulate nature of the cyanobacterial species that dominated the phytoplankton. Algae contained in larger particles do not impact water clarity as much as small algae that produce cloudiness when abundant.

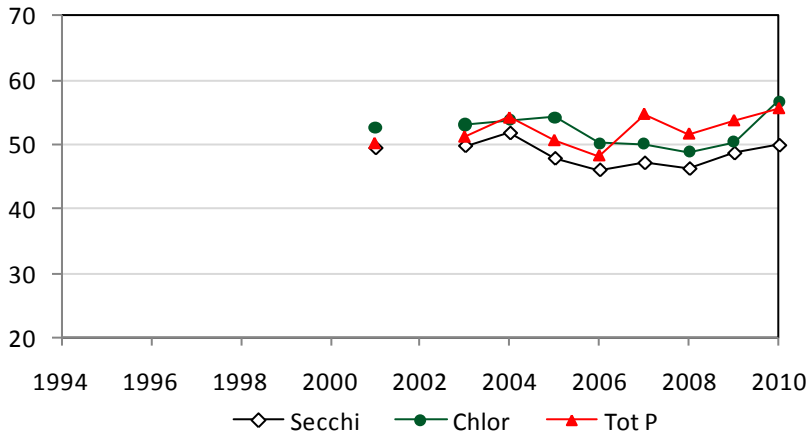

Figure 5. TSI Values at Echo Lake

Cyanobacteria toxins

Because of its history of occasionally producing bluegreen (cyanobacteria) blooms, Echo Lake was chosen as one of 30 Puget lowland lakes to be studied as part of work funded by a grant from the Center for Disease Control (CDC) to the Washington Department of Health, working with the collaboration of King, Snohomish, and Pierce Counties. The study involves regular biweekly sampling at a selected site for bluegreen species abundance and toxicity between June and October for three consecutive years, of which 2010 was the second year. Four algal toxins were measured in 2010: microcystin, anatoxin, saxitoxin and cylindrospermopsin.

In Echo Lake, the routine site chosen for monitoring was at the public park because that is the point at which the most people and pets come in contact with the water. All toxins were below detectable levels on first date sampled in 2010 season. However, microcystin was present at low levels for the rest of the routine monitoring period, always less than 1 ug/L. No detectable amounts of the other 3 toxins were found. Aside from the routine samples, one bloom sample in mid June was submitted under the Washington Department of Ecology algae program, and that sample had a detectable amount of microcystin that was less than 1 ug/L as well.

Conclusions and Recommendations

Based on the monitoring data, water quality in Echo Lake appears to have been relatively stable over the period measured, although 2010 recorded the highest trophic state

indicator average for the entire sequence. Low N:P ratios throughout most of the monitoring period indicated conditions favorable for nuisance bluegreen algae blooms. Close monitoring of algae blooms at the lake in the fall should continue, including participation in the CDC grant project and the Washington State Department of Ecology's Toxic Algae Monitoring program to determine whether or not blooms at the lake produce toxins above the recommended recreational threshold on a regular basis. Continued monitoring of nutrient and chlorophyll concentrations may produce more reliable predictions of future conditions.